Example interpretation of standard 

**Grade 12 Chemistry standard 14.4**

Explain the shapes of simple covalent molecules in terms of electron-pair repulsion (including lone pairs) and know how molecular shape can give rise to permanent dipoles.

What does ‘explain’ mean?

This **could be** interpreted in terms of three learning objectives **or** learning intentions **or** performance criteria:

1. Sharing of electrons is illustrated by drawing Lewis diagrams (from Grade 10 standard 15.6)
2. Shapes of molecules are predicted using valence shell electron pair repulsion theory.
3. Polarity of molecules is predicted using shape and bond polarity as appropriate.

Range: molecules obeying the octet rule (is this what ‘simple molecules’ means?)

**Delivery:** As suggested.

**Supplementary materials:** (page references to appropriate text should be included here)

**Lewis diagrams**

Draw Lewis diagrams for the following molecules.

**1** NH3

**2** HCN (C is the central atom)

**3** O2

**4** CCl4

**5** OF2

**6** BH3

**Bonding – shapes key facts**

|  |  |
| --- | --- |
| **1** | Clouds of electrons will be arranged as far \_\_\_ as possible around each atom. |
| **2** | The shape made by three clouds of electrons around a central atom is \_\_\_ \_\_\_. |
| **3** | If a molecule has four bonding and no non-bonding electron clouds around its central atom its shape will be a \_\_\_. |
| **4** | A molecule with one non-bonding and three bonding electron clouds around its central atom will form a \_\_\_ \_\_\_. |
| **5** | An ionic bond forms when electrons are \_\_\_ to form oppositely-charged ions. |
| **6** | If a molecule has \_\_\_ bonding and no non-bonding electron clouds around its central atom the shape will be trigonal planar. |
| **7** | A covalent bond forms when atoms \_\_\_ electrons. |
| **8** | If a molecule has two bonding and two non-bonding electron clouds around its central atom the shape will be \_\_\_. |

**Shapes of molecules**

What is the shape of these molecules?

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | trigplanar | **5** | linear2 |
| **2** | bent2 | **6** | tetrahedral |
| **3** | linear | **7** | bent |
| **4** | trigpyramid |  |  |

**Bonding – polarity key facts**

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | An atom’s \_\_\_ indicates how strongly it attracts electrons within a bond. | **5** | A thin stream of a \_\_\_ liquid will bend towards a charged rod. |
| **2** | Within-molecule forces are called \_\_\_-molecular forces. | **6** | Between-molecule forces are called \_\_\_-molecular forces. |
| **3** | Metals have \_\_\_ electronegativities. | **7** | A thin stream of a non-polar liquid will not be affected by a \_\_\_ rod. |
| **4** | The element with the highest electronegativity is \_\_\_. | **8** | A compound can have polar bonds but be non-polar if the dipoles are \_\_\_. |

**Lewis diagrams, shapes and polarity**

Draw Lewis diagrams for these molecules, then use the diagram to determine the shape of the molecule.

**1** CH2O (carbon is the central atom)

**2** Cl2

**3** HOCl (O is the central atom)

**4** CH3OH

**5** PCl3

**Assessment** **Task 1: *Predict the Shapes and Polarity of Molecules****.*

1. *Sharing of electrons is illustrated by drawing Lewis diagrams.*
2. *Shapes of molecules are predicted using valence shell electron pair repulsion theory.*
3. *Polarity of molecules is predicted using shape and bond polarity as appropriate.*

##### Instructions & Conditions

This is a closed book assessment. Candidates complete the tasks individually and all work should be the candidates’ own.

Time allowed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In this assessment candidates will demonstrate the ability to predict both the shapes and polarity of molecules by answering the given questions correctly.

1. *Sharing of electrons is illustrated by drawing Lewis diagrams.*
2. *Shapes of molecules are predicted using valence shell electron pair repulsion theory.*

**Question 1.** Six compounds are given in the table below. Complete the table by:

a) Drawing the Lewis diagrams illustrating sharing of electrons; and,

b) Predicting the shape of the molecule. The shape may either be named or drawn using a 3-D diagram.

|  |  |  |
| --- | --- | --- |
| **Chemical Formula of Element or Compound** | **Lewis Diagram** | **Predicted Shape** |
| 1. H2O |  |  |
| 1. HF |  |  |
| 1. COCl2 |  |  |
| 1. Cl2 |  |  |
| 1. HOCl |  |  |
| 1. NH3 |  |  |

1. *Polarity of molecules is predicted using shape and bond polarity as appropriate.*

**Question 2.** For the six compounds in Question 1, predict whether the molecule is polar or non-polar. Cross out the incorrect answer.

a) H2O Polar / Non-polar

b) HF Polar / Non-polar

c) COCl Polar / Non-polar

d) Cl2 Polar / Non-polar

e) HOCl Polar / Non-polar

f) NH3 Polar / Non-polar

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name: |  | | Date: | |  |
| **Performance Criteria** | | **Evidence Statement** | | **Judgement Statement** | | | **✓** |
| **Task One : Predict the Shapes and Polarity of Molecules** | | | | | | | |
| * 1. Sharing of electrons is illustrated by drawing Lewis diagrams.   2. Shapes of molecules are predicted using valence shell electron pair repulsion theory.   3. Polarity of molecules is predicted using shape and bond polarity as appropriate | | Candidate illustrates sharing of electrons by drawing Lewis diagrams.  Candidate names and draws the shapes of molecules using valence shell electron repulsion theory.  i. V-shaped or Angular  ii. Linear  iii. Trigonal Planar  iv. Linear  v. V-Shaped or Angular  vi. Trigonal Pyramid  Candidate predicts the polarity of the substances.  a) Polar  b) Polar  c) Polar  d) Non-polar  e) Polar  f) Polar | | Candidate correctly illustrates sharing of electrons by drawing Lewis diagrams for the given substances (1a)  Candidate correctly predicts the shapes of the molecules by both naming and drawing the shape of the given substances (1b)  Candidate correctly predicts the polarity of substances (2) | | |  |